Main and Preburner Injector Technology

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MSFC is currently conducting combustion research of injector elements using small windowed combustors. The objectives of this testing—which will be accomplished with a combination of advanced laser diagnostics and traditional engineering measurements—are to provide data that can be used to design liquid-propellant rocket injectors for optimum operation with respect to performance, heat transfer, combustion stability, and materials compatibility. The foundation of the laser measurements will be based on data sets of temperature, chemical species, velocity field, and liquid droplet distribution through the application of Raman spectroscopy, laser Doppler velocimetry, and phase Doppler particle analysis.

A test rig has been delivered to MSFC currently configured to test an Aerojet unielement combustor (fig. 41). Tests began October 15, 1995, with the initial test series to study the performance of a swirl coaxial injector element designed for use in a liquid-oxygen/gaseous-hydrogen oxidizer-rich preburner for application to the reusable launch vehicle engine concepts. The Aerojet combustor is designed to operate at pressures up to 10,300 kiloPascals (1,500 pounds per square inch).

In parallel, an effort to build a NASA-owned combustor is underway. This combustor will be designed and fabricated in-house and has been

FIGURE 41.—Main and preburner injector technology.

currently designated as the Modular Combustion Test Article. This test article will be designed for higher operating pressures, with the capability of testing single- and multiple-element configurations with liquid-oxygen flow rates up to 4.5 kilograms per second (10 pounds per second). A modular design concept will allow operating pressures of up to 41,300 kiloPascals (6,000 pounds per square inch) to be tested in an unwindowed configuration, with plans to attempt windowed measurements at pressures above 13,800 kiloPascals (3,000 pounds per square inch).The Modular Combustion Test Article will support the engine development for the Reusable Launch Vehicle program. Injector technologies identified for the study include improved fuel-rich preburners with respect to turbine environment and throttleability, oxidizer-rich preburner injector design, gas-gas injector design, and improved liquid-gas main injectors. The test article has also been identified as a possible test-bed for liquid-oxygen-rich materials testing. The current plan is to phase from the Aerojet test article to the Modular Combustion Test Article in March 1996.

In the past, engine development has involved extensive trial and error testing of much larger hardware with much more limited data, making substantial technology advances prohibitively expensive. Use of small windowed combustors for designing rocket engine injectors represents an application of state-of-the-art technology that will greatly reduce development time and costs of new engine hardware.

Sponsor: Office of Space Access and Technology

Industry Involvement: Aerojet Tech Systems, Pratt & Whitney

University Involvement:
Pennsylvania State University, University of Alabama in Huntsville